Vera Herceg Mandić,
Anđelija Ivkov-Džigurski
Serbia

The New Educational Review

Effects of PBL Implementation on Teaching of Geography in High School

Abstract

Problem-Based Learning (PBL) represents a major development and change in educational practice that continues to have a large impact across subjects and disciplines worldwide. PBL is a successful teaching and learning strategy used to engage students in deep rather than surface learning and where the learning is student focused rather than teacher focused (Biggs,1999). The paper presents the comparison of PBL with traditional learning in the teaching of geography in high school. Comparative analysis of the results of the pedagogical experiment, which included three high schools, 14 classes with 339 students, is carried out. In the statistical analysis of data t-test was used to check the hypothesis on the differences of the arithmetic means. The results of the final test showed that there was a significant difference in the arithmetic means between the students who had taken a PBL course and the students who had taken a traditional course. It can be concluded that PBL has a positive impact on improving student achievement in the learning of geography in elementary and secondary schools.

Keywords: *problem-based learning, teaching methods, geography teaching, group work*

Introduction

In this paper we describe the use and implementation of problem-based learning (PBL) in the teaching of geography in high schools in Novi Sad. Many demands of modern teaching practice can be met by the right choice of methods, forms of

work, and by appropriate use of modern teaching technologies. In order to make students learn more efficiently and acquire higher quality knowledge in classes, the teacher has to stimulate the students' activity. This is not always easy because students differ in their prior knowledge, psychophysical characteristics and abilities. Problem-based learning is one of the ways to achieve success in learning which takes into account students' individual abilities. We used the highly structured seven-step PBL procedure introduced at Maastricht University. The purpose was to monitor the students' individual learning processes and their experiences with the PBL group work. The way in which the PBL method was carried out is described. In order to measure the learning outcome from the students' point of view, learning methods were evaluated. Quantitative measurements from a questionnaire focusing on the student's learning approach were used. The presented experiment showed that this form of work contributed to a greater success of students in mastering geographical contents.

Research General Background

Problem based learning was popularized during the 1960s as a result of research by Barrows (Barrows & Tamblyn, 1980). Initially PBL was introduced at McMaster University and Case Western Reserve Medical Schools, and during the 1970s in medical schools, e.g., at Newcastle (Australia), Maastricht and New Mexico Universities. As an approach to learning, PBL has spread across the world since the 1970s (Savin-Baden, 2000) and is currently practiced in the United States, Canada, Europe, Singapore and Australia (Dolmans et al., 2005; Savin-Baden, 2000; Schwartz et al., 2001). Problem-based learning has been introduced to all of the health sciences, engineering, business, science, agriculture and education (Boud & Feletti, 1991; Schwartz et al., 2001). A special question is how widely has problem-based learning been used in geography, a discipline which is rather remote from the disciplines in which it originally flourished – medicine and engineering. In their study, Powson et al. (2006) offered some answers to these questions. Also, implementing a problem-based learning approach in teaching geography was considered by many authors, e.g., Chappell (2001), King (2001), Savin-Baden (2001), Fournier (2002), Sproken-Smith (2005, 2008), Cachinho (2008).

Problem-based learning (PBL) is one of the clusters of recent innovations in active learning, with a wide range of positive outcomes for students (Powson et al., 2006). Further, Agnew (2001) points out that the supporters of such innovations mainly declare that they promote profound learning through a better

understanding of the concepts and skill development, as well as encourage student participation, motivation and inspiring classes. These authors also consider PBL as a learning method and strategy or as a curricular philosophy (Maudsley, 1999). Problem-based learning represents a major development in educational practice that continues to have a large impact on subjects and disciplines worldwide. Duch, Groh, and Allen (2001) described the methods used in PBL and the specific skills developed, including the ability to think critically, analyze and solve complex, real-world problems, to find, evaluate, and use appropriate learning resources; to work cooperatively, to demonstrate effective communication skills, and to use content knowledge and intellectual skills to become continual learners.

Problem-based learning, as a system of procedures and resources, enables creative participation in the process of new knowledge acquisition. Problem solving is an activity which contributes to the formation of creative thinking and cognitive activities, which is of great importance for the versatile development of personality. In problem-based learning, new solutions are sought through thinking activities of different kinds and combinations. In problem solving, every student, or a group of students working together, can choose their own way and mode of work. The process involves engagement of most complex thinking activities, as the problem encountered requires responding in a new way.

Research Methodology

Research Problem

Although it is difficult to give a precise definition of PBL, it is possible to list some fundamental principles of PBL (de Graaff, 2003). It starts with a problem and includes participant direction, experience, activity, interdisciplinarity, exemplarity and group work. The problem space, domain and context have to be analyzed, and problem definition and requirements need to be defined. Team members play different roles, which must be clear to everybody. A team working together is much more powerful than individuals working alone. Brainstorming and creative work in a free and open atmosphere induce innovative ideas and solutions. The learning process is iterative, and a somehow structured process is necessary in order to deliver in due time.

This paper concerns PBL in the teaching of geography in high schools. The goal was to create a situation in which students learn individually, guided by the teacher. The objective was to investigate the contribution of the above model to mastering geographical contents, compared to the traditional way of work.

Research Aims

The aim of this research was to investigate the effects of the implementation of PBL on geography teaching in high schools. The educational content for this research was the teaching units "Chemical and physical properties of seawater" (first experimental group), "Australia and Oceania" (second experimental group) and "The Pannonian Plain" (third experimental group).

These teaching units provide numerous possibilities for a creative approach to presentation. Textbooks were used (Гавриловић & Гавриловић, 2009, Ђурић, 2004, Родић, 2003), as well as data, photographs, and sketches collected on the Internet, along with some materials prepared by the teacher.

In order for the group work to bring about the desired positive results, the subject matter of each teaching unit was divided into logical subunits. The task of each group was to define the corresponding geographical objects and phenomena, present the pertinent numerical data in the form of tables, mark their position on the blank chart, attach photographs (if any), and comment on their economic and tourist significance.

In order to achieve the planned research aim, the following tasks had to be undertaken:

- Initial testing of the students and comparing their general success at schools and success in geography shown by their grades, in order to establish their prior knowledge of geography.
- Design of appropriate teaching materials for problem-based learning and group work.
- Conducting a pedagogical experiment with parallel groups and introducing an experimental factor – problem-based learning and group work.
- Final testing for establishing the efficiency of experiments in knowledge building.

Research Hypothesis

By introducing an independent variable – problem-based learning, in the experimental groups, we intended to determine its effect on the students' knowledge. The null hypothesis was formulated as "There is no statistically significant difference in the average points between the experimental and control groups". The arithmetic means were compared using t-test and using the SPSS and MS Excel software packages.

Research Sample

The experiment was carried out in the school year 2011/12 and encompassed 339 students from three high schools in the city of Novi Sad, Serbia. These students

formed three experimental groups: E1, (40 students from two first grades), E2 (62 students from three second grades) and E3 (43 students from two third grades), and three corresponding control groups K1 (56 students from two first grades), K2 (80 students from three second grades) and K3 (58 students from two third grades). The experimental groups consisted of 145 students, and the control groups of 194 students.

The general success at school and the success in geography reflected in the students' grades show that in the experimental and control groups there were students with similar knowledge. The groups were uniform as there was no statistical difference between them in respect of the marks either in geography or the average mark in all other subjects. Also, equalization of the groups was made with the use of a knowledge test.

Instrument

The instrument used in this research was a test specially designed for this investigation. The test consisted of 36 questions and the maximum score was 72 points. In order to check the reliability of the measuring scale, Cronbach's Alpha was used. Ratio over 0.7 was considered acceptable, and coefficients greater than 0.8 were considered good. In this study for 36 variables that related to the various elements of geography knowledge, Cronbach's Alpha was 8.66, and it was concluded that the measurement scales used were reliable.

Phases and procedures in investigation

The research consisted of three phases. In thte first phase, initial testing and group equalizing took place (autumn 2011). In the second phase, the control groups attended a lecture presented in the traditional way and the experimental groups did 90-minute group work. In the third phase, final testing was performed with both the control and experimental groups. The test was given 7 days after the lecture, i.e. in the subsequent class.

The procedure described here applies to the teaching unit "Australia and Oceania". Teaching units "Chemical and physical properties of seawater" and "The Pannonian Plain" were handled in the same way.

In each class, the students were divided into seven groups, according to their seats. The groups consisted of 3, 4 or 5 students.

At the beginning of the group work, each group obtained written materials from the teacher, with specific questions, tasks, data, photos, sketches and figures, and each student in the group was assigned a specific task by the instructions. The teacher gave some additional instructions and appointed a leader in each

group, and the group leader obtained a table to be filled in. Group members were supposed to put their heads together, to split the task into smaller units, to work cooperatively, and to prepare the report about their work. Besides, they were told they could also use common materials prepared for the whole class – geographical maps hanging in the classroom, atlases, encyclopedias and the Internet.

A number of photographs, drawings and sketches were copied and distributed to the students. Short texts about Cook, Magellan, George Harrison and his chronometer and about Vasco da Gama were also given. Additionally, several short news items like: the one of March 11, 2011 at 15:39 | cdc/if| photo: afp Earthquake in Japan: Earth axis shifted by 10 cm; January 17, 2011, 12:59 (Srna agency): Australia. The worst natural disaster in the history of the continent; July, 18, 2010, 17:27 (Beta agency): photo: Reuters-Two intense earthquakes struck Papua New Guinea, as well as the blank maps of the world and its parts were also made available. Abundance of historical data related to Magellan's, Cook's and Vasco da Gama's journeys, the Titanic disaster, as well as to the most famous channels and seas, were also used to arouse the students' interest in the presentation of given teaching units.

The questions posed to each group were intended to enable easier and simpler revealing and tracing the part of knowledge necessary to answer them. The basic questions were of a problem type and they were almost always implied in the title of the teaching unit or some part of it. Here are some of these questions:

1. *Look at the map of Cook's journeys. Why did Cook travel so? Did Cook get lost during his journeys or was he looking for something? Explain.*
2. *What does the word "Aborigine" mean? What is the characteristic of the Aborigines?*
3. *One part of Australia has recently been struck by a natural disaster. Which part was it and what was that disaster?*
4. *Name some animal species which you can meet only in Australia.*
5. *Which tropical plants are characteristic of Oceania?*
6. *The population of Australia and Oceania in 1800 was 0.22% of the world's population, and in the year 2000 about 0.54%. How can we explain this increase?*
7. *In Oceania, earthquakes are frequent. How can this be explained?*

In these questions, there are some data which can be found in the student textbook (Гавриловић & Гавриловић, 2009). However, some good answers could not be given by the students based only on their knowledge and the books. They were made to realize that they were missing certain knowledge, and this created a problem. Hence, they not only had to solve a demanding task based on their existing knowledge, even by doing their best, but a problem that could be solved

only through dealing with the problem itself. So, the students were brought into the situation to search for new knowledge, to acquire new information, formulate the stages of solving the problem, and arrive at a solution that is to be presented.

The experimental work, as one block class, lasted 90 minutes. In the preceding class, the teacher heralded the forthcoming teaching unit and the class was going to be different from the previous classes. It was pointed out that the students were going to present the unit by themselves and draw conclusions under the guidance of the teacher. They were also told about their obligations related to this. They were asked to bring drawing accessories, pocket calculators and the geography textbook, as well as their school atlases, possible literature sources and the results of their Internet search (text, sketches and other pertinent data).

After 40 minutes of joint work, the group had to present its report in the form of a poster. The time for poster presentation was 20 minutes, during which all the students, together with the teacher, inspected and discussed the posters.

At the end, after all the groups had presented their results, the teacher made a short summary of the teaching unit, emphasizing the most important points. In that way, all the students were able to get the impression about the results of the group work and revise the unit once again. When evaluating the students' work, the teacher gave her/his opinion about the presented contents and suggested alternative forms of presentation. In that way, the teacher was also guiding the students' future work.

Applied methods

In this research, the method of pedagogical experiment with parallel groups was used. During the pedagogical experiment, the following methods were applied: method testing, monologue and dialogue method, group work. Results were statistically processed and presented using the SPSS and MS Excel software.

Research Results

For the sake of brevity, the teaching units are denoted by HF for "Chemical and physical properties of seawater", AO for "Australia and Oceania" and PP for "The Pannonian Plain".

Initial testing

Initial testing was conducted with the aim to establish if the groups had an equal prior knowledge level. Basic statistical parameters of achievement of the

experimental and control groups obtained by initial testing are shown in Table 1. Comparison of the average scores of the control and experimental groups reveals that there is no statistically significant difference between the groups ($p = 0.067$ for HF, $p = 0.993$ for AO and $p = 0.915$ for PP students in the 95% confidence level). This indicates that the groups were equal before conducting the planned pedagogical experiment.

Table 1. Results of the experimental and control groups on the initial test

Teaching unit	Group	Number of students	Average points	Standard deviation	*t*	*p*
HF	E1	40	59.45	4.47	-1.98	0.067
	K1	56	61.75	6.88		
AO	E2	62	61.45	7.52	-0.01	0.993
	K2	80	61.46	7.00		
PP	E3	43	63.14	3.88	0.107	0.915
	K3	58	63.05	4.24		

Final testing

The knowledge test was aimed at getting an insight into the students' success in mastering the given teaching unit, and, based on the statistical indicators, looking for possible differences. This served as the basis for drawing conclusions about the potential contribution of the model to a more successful mastering of the given geographical contents. The questions were formulated in the same way as in the textbook.

The basic statistical parameters of the achievement of the control and experimental groups obtained in the final testing are presented in Table 2. Based on the obtained data, the null hypothesis was checked, i.e., if there is no statistically significant difference in average points between the experimental and control groups.

By comparing the results between the first experimental and control groups, the null hypothesis can be rejected with the 95% confidence level, since $p < 0.05$. The same conclusion also holds in the case of the second and third groups. This means that there is a statistically significant difference in the average points, i.e., the control groups had statistically significantly lower average points.

The results of the knowledge test are an illustrative proof that the experimental groups mastered better the given teaching unit.

Table 2. Results of the experimental and control groups on the final test

Teaching unit	Group	Number of students	Average points	Standard deviation	*t*	*p*
HF	E1	40	62.33	5.25	2.40	0.0184
	K1	56	59.13	7.17		
AO	E2	62	56.48	7.19	2.20	0.0389
	K2	80	53.01	11.48		
PP	E3	43	68.05	2.18	4.28	0.0002
	K3	58	65.64	3.45		

Conclusions

Many demands of modern teaching practice can be satisfied by the right choice of methods, forms of work, and by appropriate use of modern teaching technologies. In order to make students learn more efficiently and acquire higher quality knowledge in classes, the teacher has to stimulate the students' activity. This is not always easy because students differ in their prior knowledge, psychophysical characteristics and abilities. One of the ways to achieve success in learning, which takes into account students' individual abilities, is problem-based teaching.

The presented experiment showed that this form of work contributes to a better success of students in mastering geographical contents. The effort that the teacher should make in preparing and conducting teaching in a described way is not too big, and it notably contributes to a better teaching process, and the final success of the students.

The success of the application of this method depends on many factors. First of all, it is important to choose a good problem, make good preparation, and select appropriate written materials along with materials of some other kind. Also, the teacher's readiness to spare a certain amount of time for this form of work is of importance. The results of applying such a model are good, and the students are satisfied, so it should be applied more often.

Through PBL, the students made use of competences which are developed to a smaller extent in traditional teaching and learning. This is related to the competence of solving problems, making decisions, team work, cooperative learning, independent work, as well as critical and creative thinking. The students were instructed to collect information from different sources (including the teacher). The students also learned how to compare the obtained information with that obtained by the members of the groups and thus they became aware of their own

strengths and weaknesses in the process of learning. By working in a group, the students had the opportunity to develop the skill of appreciating the opinions of others and value their own contribution to the results achieved by the group. Active use of information will facilitate their storing in the long-term memory.

Based on the experience gained in the conducted research, it can be concluded that in geography teaching it is not of primary importance to single out and solve only a few "right problems" in the course of one school year. Quite contrary, everyday teaching practice should create such situations in which students will be engaged in working both individually and in the group, to be able to apply the acquired knowledge, and to be constantly in search of new information, as well as the cause-effect relationships between geographical phenomena and concepts.

The quantitative evaluation results clearly indicate that the use and implementation of the PBL procedure in a single course as part of a traditional curriculum has been a success. We may conclude that the outcome of this learning process is indeed better. The students have not only obtained competence within the traditional curriculum, but also additional inter-personal and intra-personal teamwork skills.

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